WHAT IS CLAIMED IS:

1. A device for driving a solenoid, comprising:

a power supply;

a switching element connected between said power supply and said solenoid in series therewith;

a current circulating diode connected in parallel to said solenoid so that the cathode of said current circulating diode is connected between said switching element and said solenoid;

a current detecting circuit for detecting an actual current flowing through said solenoid;

PID computing means for computing an on-duty value and an off-duty value according to a difference between a target current and said actual current detected by said current detecting circuit, and outputting said on-duty value and said off-duty value;

PWM duty driving means for generating a PWM duty signal according to inputting of said on-duty value and supplying said PWM duty signal to said switching element to on/off control said switching element; and

reverse voltage applying means capable of applying a voltage of said power supply as a reverse voltage to said solenoid according to inputting of said off-duty value when said switching element is off.

2. A device according to claim 1, wherein said reverse voltage applying means comprises:

a second switching element connected between the negative electrode of said power supply and said solenoid in series therewith;

a second current circulating diode connected in parallel to a series circuit composed of said switching element and said solenoid so that the cathode of said second current circulating diode is connected between said power supply and said switching element; and

second PWM duty driving means for generating a second PWM duty signal according to inputting of said off-duty value and supplying said second PWM duty signal to said second switching element to on/off control said second switching element.

3. A device according to claim 2, wherein said reverse voltage applying means further comprises:

off-duty value selecting means for selecting said off-duty value output from said PID computing means; and

an adder for adding +1 to said off-duty value.

4. A device according to claim 2, wherein said second PWM duty driving means comprises a PWM timer and a driver circuit.

5. A device according to claim 1, wherein said

reverse voltage applying means comprises:

a second switching element connected between the negative electrode of said power supply and said solenoid in series therewith;

a second current circulating diode connected in parallel to a series circuit composed of said switching element and said solenoid so that the cathode of said second current circulating diode is connected between said power supply and said switching element;

absolute value calculating means for calculating the absolute values of said on-duty value and said off-duty value;

an inverter for inverting the signs of said on-duty value and said off-duty value;

a NAND circuit adapted to input an output from said absolute value calculating means and an output from said inverter; and

a driver circuit for on/off controlling said second switching element according to an output from said NAND circuit.

6. A device according to claim 1, wherein said PID computing means comprises:

integral term calculating means for calculating an integral term according to the difference between said

target current and said actual current; and

means for resetting said integral term to 0 when said actual current becomes a predetermined value or less.

7. A device according to claim 1, wherein said power supply comprises a single power supply.

8. A device for driving an electromagnetic actuator including a ringlike core member having an annular groove, an annular solenoid accommodated in said annular groove of said core member, and a ringlike armature member opposed to said core member with a given gap defined therebetween, said device comprising:

a power supply;

a switching element connected between said power supply and said solenoid in series therewith;

a current circulating diode connected in parallel to said solenoid so that the cathode of said current circulating diode is connected between said switching element and said solenoid;

a current detecting circuit for detecting an actual current flowing through said solenoid;

PID computing means for computing an on-duty value and an off-duty value according to a difference between a target current and said actual current detected by said current detecting circuit, and outputting said on-duty

value and said off-duty value;

PWM duty driving means for generating a PWM duty signal according to inputting of said on-duty value and supplying said PWM duty signal to said switching element to on/off control said switching element; and

reverse voltage applying means capable of applying a voltage of said power supply as a reverse voltage to said solenoid according to inputting of said off-duty value when said switching element is off.

9. A device according to claim 8, wherein said reverse voltage applying means comprises:

a second switching element connected between the negative electrode of said power supply and said solenoid in series therewith;

a second current circulating diode connected in parallel to a series circuit composed of said switching element and said solenoid so that the cathode of said second current circulating diode is connected between said power supply and said switching element; and

second PWM duty driving means for generating a second PWM duty signal according to inputting of said off-duty value and supplying said second PWM duty signal to said second switching element to on/off control said second switching element.

10. A device according to claim 9, wherein said reverse voltage applying means further comprises:

off-duty value selecting means for selecting said off-duty value output from said PID computing means; and

an adder for adding +1 to said off-duty value.

11. A device according to claim 9, wherein said second PWM duty driving means comprises a PWM timer and a driver circuit.

12. A device according to claim 8, wherein said reverse voltage applying means comprises:

a second switching element connected between the negative electrode of said power supply and said solenoid in series therewith;

a second current circulating diode connected in parallel to a series circuit composed of said switching element and said solenoid so that the cathode of said second current circulating diode is connected between said power supply and said switching element;

absolute value calculating means for calculating the absolute values of said on-duty value and said off-duty value;

an inverter for inverting the signs of said on-duty value and said off-duty value;

a NAND circuit adapted to input an output from said

absolute value calculating means and an output from said inverter; and

a driver circuit for on/off controlling said second switching element according to an output from said NAND circuit.

13. A device according to claim 8, wherein said PID computing means comprises:

integral term calculating means for calculating an integral term according to the difference between said target current and said actual current; and

means for resetting said integral term to 0 when said actual current becomes a predetermined value or less.

14. A device according to claim 8, wherein said power supply comprises a single power supply.

15. A control device for an electromagnetic actuator including a core member having a groove, a solenoid accommodated in said groove of said core member, and an armature member opposed to said core member with a gap defined therebetween, said control device comprising:

gap detecting means for detecting said gap between said core member and said armature member;

current detecting means for detecting an actual current flowing through said solenoid;

a feedback controller for feedback controlling said

actual current so that said actual current becomes equal to a target current;

a feedforward controller for feedforward controlling said target current; and

solenoid drive signal generating means for generating a solenoid drive signal according to outputs from said feedback controller and said feedforward controller;

said feedback controller changing an integral term constant according to said gap detected by said gap detecting means.

16. A control device according to claim 15, wherein said feedback controller selects one of a plurality of predetermined integral term constants according to said gap detected by said gap detecting means.

17. A control device according to claim 16, wherein said feedback controller selects a larger one of said integral term constants when said gap is large, and selects a smaller one of said integral term constants when said gap becomes smaller.

18. A control device according to claim 15, wherein said feedforward controller changes a transfer function and/or a gain according to said gap detected by

said gap detecting means.

19. A control device according to claim 18, wherein said feedforward controller selects one of a plurality of predetermined transfer functions and/or one of a plurality of predetermined gains according to said gap detected by said gap detecting means.

20. A control device according to claim 19, wherein said feedforward controller selects a smaller one of said transfer functions and/or a smaller one of said gains when said gap is large, and selects a larger one of said transfer functions and/or a larger one of said gains when said gap becomes smaller.

21. A control device according to claim 15, wherein said gap detecting means comprises a magnetic flux sensor for detecting a magnetic flux intensity generated from said solenoid.

22. A control device according to claim 15, further comprising a target filter provided on the front stage of said feedback controller and adapted to input said target current.

23. A control device for an electromagnetic actuator including a core member having a groove, a solenoid accommodated in said groove of said core member, and an armature member opposed to said core member with a

gap defined therebetween, said control device comprising:

gap detecting means for detecting said gap between said core member and said armature member;

current detecting means for detecting an actual current flowing through said solenoid;

a feedback controller for feedback controlling said actual current so that said actual current becomes equal to a target current;

a feedforward controller for feedforward controlling said target current; and

solenoid drive signal generating means for generating a solenoid drive signal according to outputs from said feedback controller and said feedforward controller;

said feedforward controller changing a transfer function and/or a gain according to said gap detected by said gap detecting means.

24. A control device according to claim 23, wherein said feedforward controller selects one of a plurality of predetermined transfer functions and/or one of a plurality of predetermined gains according to said gap detected by said gap detecting means.

25. A control device according to claim 24, wherein said feedforward controller selects a smaller one

of said transfer functions and/or a smaller one of said gains when said gap is large, and selects a larger one of said transfer functions and/or a larger one of said gains when said gap becomes smaller.

26. A control device according to claim 23, wherein said gap detecting means comprises a magnetic flux sensor for detecting a magnetic flux intensity generated from said solenoid.

27. A control device according to claim 23, further comprising a target filter provided on the front stage of said feedback controller and adapted to input said target current.